Chapter 3

Description of the study area

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This study examines groundwater resources that underlie the Snake/Salt River drainage basin in Wyoming, as well as tributary areas in Idaho (**fig. 3-1**). The Snake/Salt River Basin in Wyoming covers approximately 5,113 square miles (3.27 million acres), or 5.2 percent of Wyoming's surface area. The tributary watershed in southeastern Idaho is small, about 432 square miles (0.28 million acres). In Wyoming, the Snake/Salt River Basin includes 81 percent of Teton, 28 percent of Lincoln, 8.5 percent of Sublette, and 1.7 percent of Fremont counties. In Idaho, the tributary watershed covers 4.5 percent of Bonneville, 18.3 percent of Caribou, 0.9 percent of Fremont, and 0.12 percent of Teton Counties. Unless specific references are made to the Idaho tributary areas, references to the Snake/Salt River Basin in this memorandum include only the Wyoming portion of the watershed.

Although, the Snake/Salt River Basin encompasses about 5.2 percent of Wyoming's total surface area, it serves as home to approximately 34,500 people or about 6.0 percent of the state's current population (WDAIEAD, 2014). The Snake/Salt River Basin contains five incorporated municipalities (Jackson, Afton, Star Valley Ranch, Alpine, and Thayne), 21 U.S. Census Designated Places (CDP), and a substantial rural population. The index map in **figure 3-1** shows townships, major roads, and incorporated municipalities within the Snake/Salt River Basin.

3.1 Physiography, landforms, topography, and surface drainage

The Snake/Salt River drainage basin is located entirely within the Middle Rocky Mountain Physiographic Province (WSGS, 2014). Major drainages, reservoirs, and physiographic features of the Snake/Salt River Basin are shown on **figure 3-2**. A map of the physiographic provinces of Wyoming is available online at http://www.wsgs.uwyo.edu/Research/Geology/images/Final/Elevations.pdf.

The overall physiography of the Snake/Salt River Basin consists of a deeply eroded geologic foundation superimposed on the Overthrust Belt in the south, the Absaroka and Yellowstone Plateau volcanic systems to the north, Laramide and subsequent uplift structures to the north and east and Basin and Range Province structures to the west. The Overthrust Belt, of eastern Idaho, northern Utah, and western Wyoming is composed of strike ridges and valleys formed during the Sevier Orogeny (125 – 55 million years ago). During that period, rocks of Paleozoic and Mesozoic age were thrust eastward by low angle, imbricated (overlapping), westward dipping thrust faults that form five thrust systems along with their associated thrust sheets. The extent of the Snake/Salt River drainage basin examined in this study (**fig. 3-1**) encompasses portions of the four earliest Sevier thrust systems. The Wyoming portion of the Snake/Salt River Basin includes the three most eastern thrust systems: the Crawford, Absaroka, and Darby sheets.

The Laramide structures (Hoback and Jackson basins and the Gros Ventre Range) on the eastern periphery of the Snake/Salt River Basin are composed of large anticlinal uplifts that have crystalline basement cores bordering large-scale synclinal basins filled with varying thicknesses of sedimentary rocks. Concurrent uplift and erosion of the highlands, and downwarping and deposition in the basins during the Laramide orogeny was followed by continued uplift, faulting, erosion, and glacial and fluvial processes.

The volcanic rocks of the Absaroka Range were formed during an period of volcanism that occurred from 53 to 35 million years ago. Subsequent deformation of the Absaroka volcanic suite occurred as a result of late and post-Laramide Laramide folding and faulting, intrusive igneous activity, slope processes, and post-volcanic extension and compaction. In comparison, the large, Pleistocene, mafic volcanic field that composes the Yellowstone-Snake River Plain (YSRP) was formed from 16 to 1 million-years ago. The YSRP volcanic system, which extends into parts of Nevada, Idaho, Montana, and Wyoming, is one of the Earth's largest silica-rich volcanic systems on Earth.

Following the Sevier and Laramide orogenies, a period of geologic extension started in the late Eocene, about 35 - 40 million years ago, and

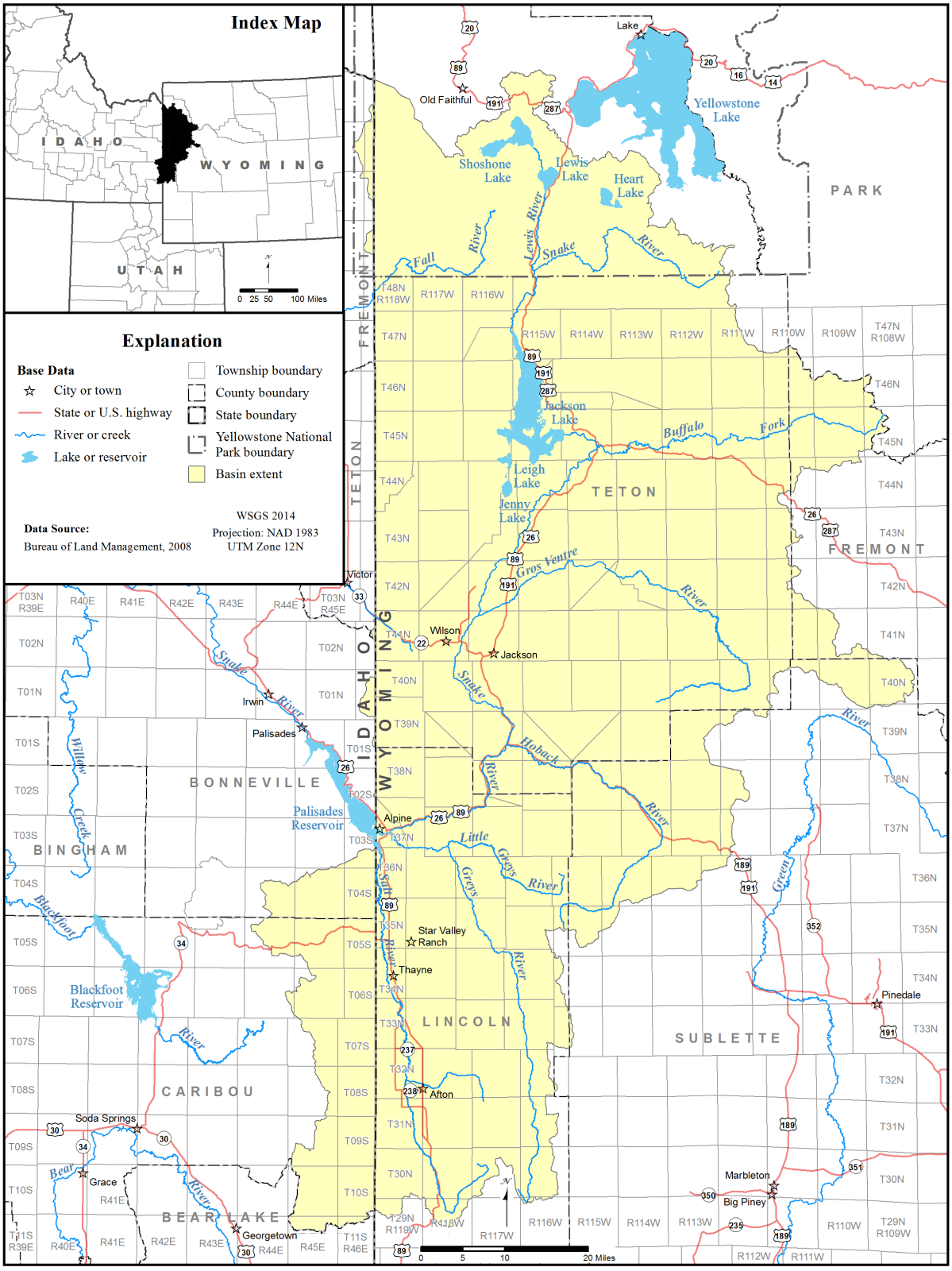

Figure 3-1. Municipality, road, township, and range index map, Snake/Salt River Basin.

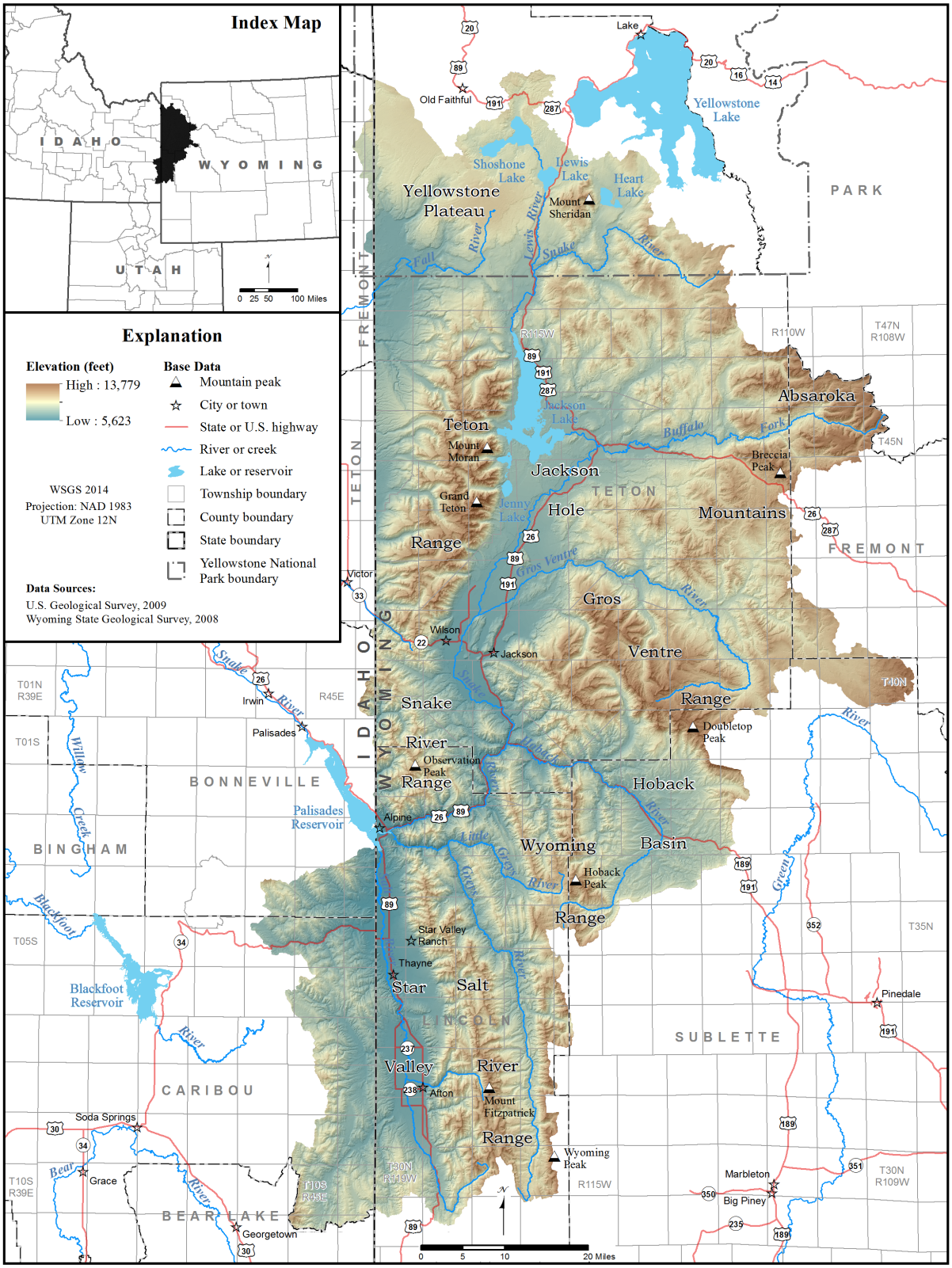

Figure 3-2. Physiographic features, drainages, and bodies of water, Snake/Salt River Basin.

continues into the present. The extension caused the formation of numerous normal faults that form the foundation of the Snake/Salt River drainage. During the Sevier Orogeny and the more recent period of geological extension, erosion, mass wasting, and fluvial processes wore down the highlands and deposited sediments in the valleys. These processes, combined with concurrent and continued faulting, resulted in the present physiography characterized by valleys alternating with north-south trending mountain ranges of variable areal scale and elevation. Elevations in the Snake Salt River Basin in Wyoming range from 5,623 feet above mean sea level where the Snake/Salt River enters the headwaters of Palisades Reservoir to 13,775 feet at the summit of Grand Teton. Detailed discussions of the geography of the Snake Salt River Basin are provided in **chapter 4** of this study.

Surface drainage in the Snake/Salt River Basin is controlled by topography. Perennial streams receive a large percentage of their source waters from overland flow associated with snowmelt and rainfall that originates in semi-humid and humid, mountainous, headwater regions and from persistent baseflow (Sunrise Engineering, 2003). Most ephemeral flow occurs in response to springtime snowmelt and to intense, short duration, rainfall events characteristic of transient, convective thunderstorms. Streamflows are also affected by vegetation, temperature, artificial diversions, and complex interconnections with groundwater.

Major drainages, reservoirs, and physiographic features of the Snake/Salt River Basin are shown on **figure 3-2** and **plate 1**. The basin encompasses the Snake/Salt River system and its tributary drainages. The Snake River is the major tributary to the Columbia River. The mainstem of the Snake River begins at the confluence of three small headstreams on the southwestern flank of Two Oceans Plateau in Yellowstone National Park. Primary tributaries that confluence with the Snake River in Wyoming include Buffalo Fork, Gros Ventre, Hoback, and Greys rivers. The headwaters of the Salt River flow from the slopes below Mount Wagner in the southern Salt Creek Range located in central Lincoln County. The Salt River confluences with the Snake River in Palisades Reservoir near Alpine, Wyoming.

3.2 Climate, precipitation, and vegetation

Climate within the Snake/Salt River Basin is primarily a function of elevation and to a lesser degree, latitude and topography. Climate types range from semi-arid continental within the interior basins, to humid-alpine in the bordering mountain ranges. The mountain ranges capture much of the atmospheric moisture through orographic uplift, resulting in increased annual precipitation in the mountainous regions while substantially decreasing precipitation in the basin interiors. Temperature varies by season from well below 0°F in the winter to more than 100°F in the summer. Annual precipitation increases with surface elevation (**fig. 3.3**) and can exceed 95 inches a year in the high mountain headwater areas of the Tetons. Annual precipitation averages 33 inches over the entire basin (PRISM, 2013). Most precipitation within the basin occurs as snowfall during the winter and early spring and as convective thunderstorms during late spring and summer months (Ahern and others, 1981).

The diversity and distribution of vegetation within the Snake/Salt River Basin is primarily influenced by elevation. The abundance of grasses, shrubs, a variety of woodland trees (primarily conifers), and other species generally increases with elevation (hence, precipitation) up to timberline above which, alpine tundra species of lichens, low shrubs, and grasses dominate flora. The dominant ecological zones are, generally, sagebrush steppe/shrubland (mixed prairie grasses and shrubs; primarily sagebrush) on the plains, mixed deciduous and coniferous forest along drainages, sub-alpine spruce-fir forest on mountain flanks and at the highest elevations, alpine tundra.

3.3 Population distribution, land use, and land ownership

The Wyoming Department of Administration and Information Economic Analysis Division

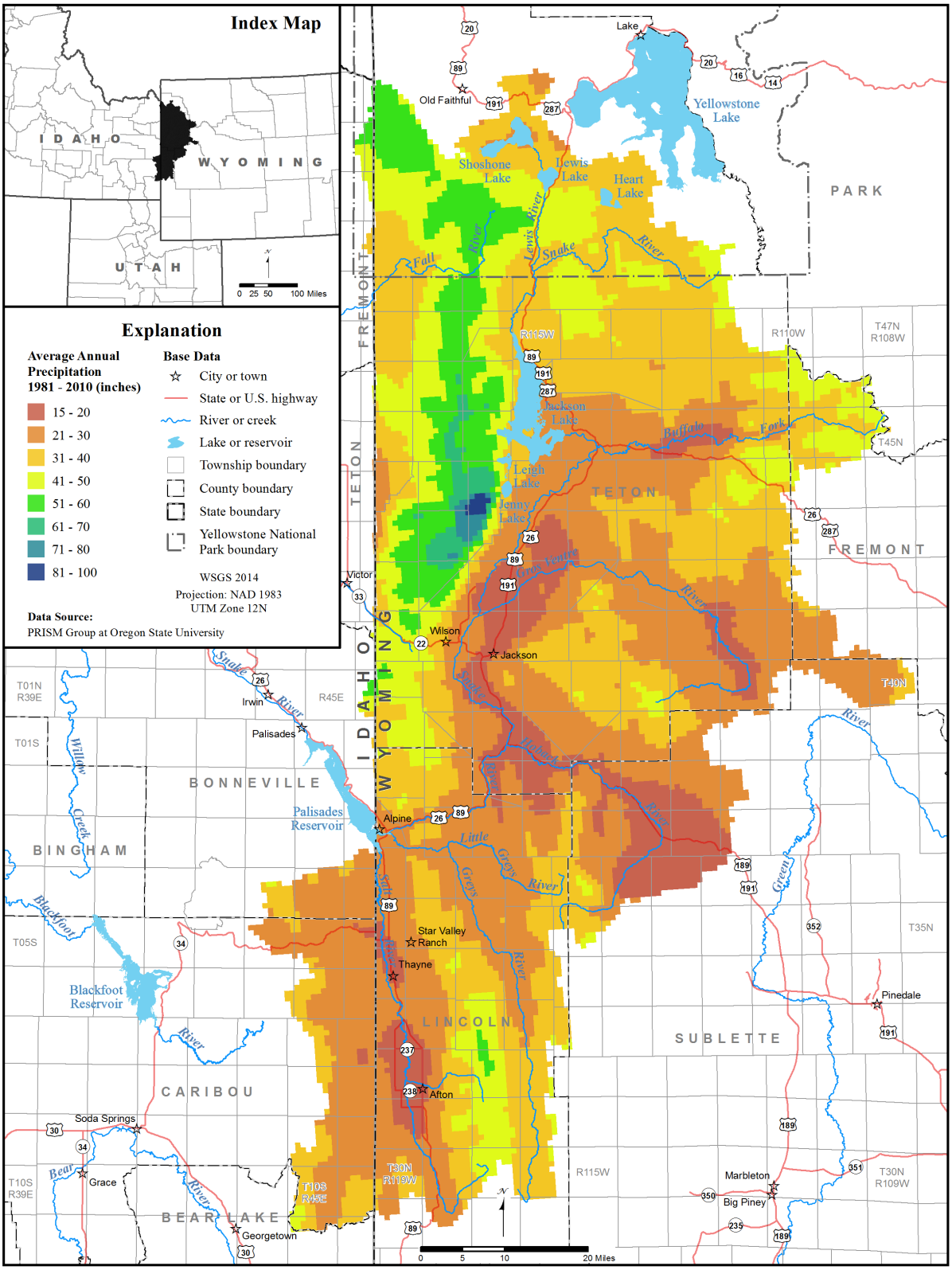

Figure 3-3. Average annual precipitation (1981 - 2010), Snake/Salt River Basin.

(WDAIEAD) estimates that 34,500 people or about 6.0 percent of the state's current population (WDAIEAD, 2014) reside in the Wyoming portion of the Snake/Salt River basin. The basin contains five municipalities and 21 U.S. Census Designated Places (U.S. Census Bureau, 2010) in Wyoming; most of these communities are located along or within a few miles of the rivers. Additional demographic information for the basin can be found online: http://waterplan.state.wy.us/plan/snake/snake-plan.html.

Land use in the Snake/Salt River Basin is controlled primarily by elevation, climate, precipitation, and land ownership. Above timberline, the alpine areas are generally used for recreational purposes. At lower elevations, thickly forested areas are utilized for recreation and limited logging. Grazing is the dominant use for rangelands, foothills, and riparian areas. Agriculture plays a significant role in the basin; approximately 3 percent (99,071 acres) of the basin's surface area consists of irrigated cropland (Sunrise Engineering, 2003). Crop producing areas are located mainly along the Salt River and sparsely scattered along the Snake River mainstem and the Hoback and Gros Ventre rivers (Sunrise Engineering, 2003). A map illustrating the distribution of the broad categories of land cover in the northwestern U.S., with downloadable GIS land cover data, is provided online by the USGS at: http://gapanalysis.usgs.gov/gaplandcover/data/.

Approximately 90 percent of the land area of the Snake/Salt River Basin is federally owned. In general, federal land in the basin is managed by the U.S. Forest Service (~2.26 million acres), the National Park Service (655,521 acres), and the Bureau of Land Management (8,056 acres). Privately owned lands, concentrated along rivers and streams, constitute about 7.8 percent of the land in the basin; 0.4 percent is owned by the state of Wyoming; and less than 2 percent is owned or managed by other entities. A map of state, federal, and private land ownership in Wyoming is available online via the Wyoming Water Development Office's 2007 Statewide Water Plan Online Presentation Tool: http://waterplan.wrds.uwyo.edu/fwp/figures/pdf/Fig3-2_3-3.pdf.